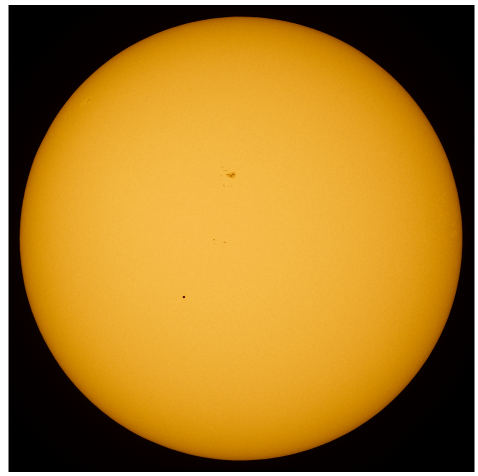
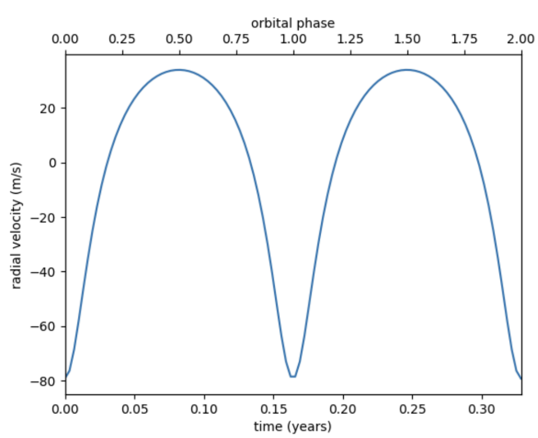
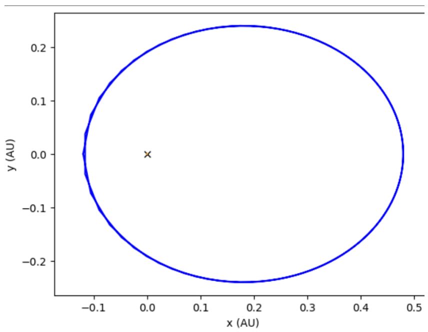
Astr 118, Physics of Planetary Systems
Discussion Week 4: Detection
Aditya Sengupta, adityars@ucsc.edu, ISB 127

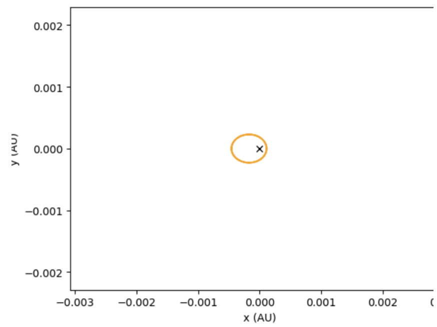
1. Guess what's in the flamingo! Whenever you have a chance and it's free, come look at the flamingo through the spectroscope. Compare what you see to the reference spectra. I'll keep track of votes on the board. There's no defined right answer to this because we don't have manufacturer information, so we'll figure it out together!
2. We can observe Mercury transiting the Sun sometimes – the last time was on 11 November 2019. We'll explore this as an analogy for detecting planets via the transit method. (You may need 1 au = 1.5×10^8 km.)



   a. Find the angular size of the Sun, given its diameter is about 1.4×10^6 km.
   b. Find the angular size of Mercury, given its diameter is about 5000 km and its semi-major axis is 0.39 au.
   c. How much of a dip in the Sun's brightness do you expect when Mercury transits the Sun?
   d. Let's repeat the calculation for a solar eclipse. The Moon has a diameter of 3500 km and is about 4×10^5 km away from us. What is its angular size and how much of the Sun's light gets blocked out?
   e. Now suppose you were looking at our solar system as if we were very far away and looking for exoplanets. How much of a dip in the Sun's brightness would you observe due to a transit of Mercury? How about due to a transit of the Moon (if it were a planet of the same size and at 1 au)?
3. Suppose we have a planet-star system as shown on the other side of the page, and the radial velocity curve shown here. The planet is orbiting counterclockwise, and orbital phase = 0 means both the planet and star are at pericenter. Which angle are we observing this system from?







The planet orbit (blue, left) and star orbit (orange, right). The star's orbit is plotted on the left diagram as well, but it's much smaller than the planet's. The X is the shared center of mass.

4. Now suppose you're looking at the system from the left relative to the top-down view plotted here. Sketch the RV curves for the following cases, keeping the convention of zero phase at pericenter:
    a. Eccentricity is low (near 0)
    b. Eccentricity is high (near 1)
    c. The center of mass flips around the y axis, so the X for the planet is on the right instead of the left.